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AI-Powered Accessibility for Enabling Effective Communication for Hearing and Speech Impaired in Virtual Platforms

U. Sriaishwarya, S. Gopika

Assistant Professor, Dept. of MCA, Gnanamani College of Technology, Namakkal, Tamil Nadu, India

PG Student, Dept. of MCA, Gnanamani College of Technology, Namakkal, Tamil Nadu, India

ABSTRACT: This project aims to create an AI-powered system to bridge the communication gap between hearing and speech-impaired individuals and hearing individuals in virtual meetings. The system features a Sign Recognition Module (SRM) for sign language interpretation, a Speech Recognition and Synthesis Module (SRSM) for text conversion, and an Avatar Module (AM) for visually translating speech into sign language. Integrated into platforms like Zoom and Microsoft Teams, this system enhances inclusivity and enables seamless, real-time communication for diverse users.

KEYWORDS: Artificial Intelligence,Machine Learing,Sing Recognition Module,Speech Recognition and Synthesis Module,Avatar Module,Sign Language Interpreation .

I. INTRODUCTION

Sign language is manual communication commonly used by people who are deaf. Sign language is not universal; people who are deaf from different countries speak different sign languages. The gestures or symbols in sign language are organized in a linguistic way. Each individual gesture is called a sign. Each sign has three distinct parts: the handshape, the position of the hands, and the movement of the hands. American Sign Language (ASL) is the most commonly used sign language in the India

A sign language (also signed language) is a language which uses manual communication, body language, and lip patterns instead of sound to convey meaning—simultaneously combining hand shapes, orientation and movement of the hands, arms or body, and facial expressions to fluidly express a speaker's thoughts. Signs often represent complete ideas, not only words. However, in addition to accepted gestures, mime, and hand signs, sign language often includes finger spelling, which involves the use of hand positions to represent the letters of the alphabet. Sign languages have developed in circumstances where groups of people with mutually unintelligible spoken languages found a common base and were able to develop signed forms of communication. Sign languages commonly develop in deaf communities, which include people who are deaf or hard of hearing, friends and families of deaf people, as well as interpreters.

II. SYSTEM MODEL

System Model:

1. SignMeet Web App

The SignMeet Web App is designed to provide a groundbreaking solution for individuals with hearing and mute disabilities in virtual meeting platforms. .

The Sign Language Recognition interface allows users to input gestures for real-time interpretation, complemented by the Speech-to-Text interface for comprehensive communication.

The Admin Dashboard provides tools for training model, monitoring and system management. This design ensures a holistic and accessible platform for individuals with hearing and mute disabilities.

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2. System User Dashboard
Admin
Login
Admin authentication for secure access to the system's administrative functions.

Build and Train SignNet Model : Dedicated functionality for the admin to initiate the building and training process of the SignNet Model.

User Management: Admin-exclusive capabilities to manage user profiles, permissions, and system maintenance tasks.

3. SignNet Model: Build and Train
In the process of building and training the SignNet Model for the Deaf Companion System, several essential steps are followed to ensure accuracy and effectiveness.

4. Sign Language Recognition 4.1. Live Video Call with Sign:
This feature facilitates real-time communication for deaf users who can express sign language gestures through their webcams. The live video feed captures the dynamic nature of sign language, allowing users to convey messages seamlessly.Employing Temporal Convolutional Networks (TCN) integrated with the SignNet Model, this step focuses on the recognition and interpretation of live sign language gestures..

The Multilanguage Interpretation feature broadens the system's accessibility by allowing interpretation of sign language gestures in multiple languages. 5. Speech Recognition and Synthesis

5.Speech Recognition: The Speech Recognition Module is designed to convert non-deaf speech into text, facilitating seamless communication with deaf individuals. Using Hidden Markov Models (HMM), the module captures the nuances of spoken language, translating them into textual representations.

The Speech Synthesis Module generates spoken language output based on the recognized text, enhancing communication for non-deaf individuals. Leveraging text-to-speech (TTS) synthesis techniques, the module creates natural-sounding spoken output**.**

6. Visual Communication : The Avatar Generation module within the Deaf Companion System, designed to elevate the experience of visual communication. Dynamic Avatar Generation is to transform the text from a normal individual into sign language, which is then executed through an Avatar.

Dynamic Avatar Generation : Utilizes the recognized speech to dynamically generate visual representations of sign language avatars. The avatars are crafted in real-time, ensuring synchronization with the flow and nuances of the communicated message.

Synchronization : Intricately synchronizes with the rhythm and content of non-deaf speech, creating a seamless and harmonious connection between spoken words and visual representation.

III. PROPOSED SYSTEM

The proposed system integrates advanced AI technologies, to create a seamless, real-time communication experience for hearing and speech-impaired individuals in virtual meetings.

Deaf Companion System
The proposed system aims to enhance communication for individuals with hearing and mute disabilities through innovative technologies.

Two-Way Communication
Implementation of a comprehensive two-way communication system, fostering seamless interaction between deaf individuals and the broader community in virtual meeting platforms.

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SignNet Model Architecture
Development of the SignNet Model, combining Convolutional Neural Networks (CNN) and Temporal Convolutional Networks (TCN) for robust sign language recognition.

Sign Language Recognition Module (SRM)
The Sign Recognition Module (SRM) utilizes Temporal Convolutional Networks (TCNs) to accurately interpret sign language in real-time.

Speech Recognition and Synthesis Module (SRSM)
The Speech Recognition and Synthesis Module (SRSM) employs Hidden Markov Models (HMMs) to transform spoken language into text, enabling easy comprehension for both deaf and hearing users **Avatar Module (AM)** The Avatar Module (AM) visually translates spoken language into corresponding sign language using 3D animation.

Integration with Virtual Platforms
The system is designed to be integrated with popular virtual platforms such as Zoom, Microsoft Teams, and Google Meet.

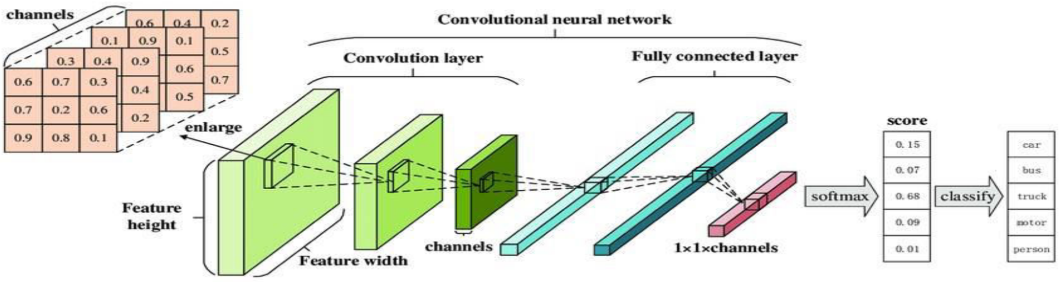
IV. SCOPE OF THE PROJECT

This project focuses on enhancing communication accessibility by integrating AI-driven sign language recognition and speech-to-text conversion into popular virtual meeting platforms. It aims to support real-time, inclusive interactions for diverse users, including those with hearing and speech impairments.

- **Inclusive Communication**: Bridges the gap between hearing and speech-impaired individuals and hearing users through AI-driven sign language recognition and speech-to-text conversion.
- **Virtual Platform Integration**: Compatible with popular platforms like Zoom, Microsoft Teams, and Google Meet to ensure accessibility in virtual meetings.
- **Real-Time Translation**: Provides instant sign-to-text, speech-to-text, and text-to-sign conversion for smooth interaction.
- **Multi-User Support**: Beneficial for deaf, hard-of-hearing, mute individuals, and non-signers, promoting effective communication.
- **AI-Driven Accuracy**: Uses **Temporal Convolutional Networks (TCN)** and **Hidden Markov Models (HMM)** to improve recognition accuracy.
- **User-Friendly Interface**: A web-based interactive platform ensures ease of use and accessibility for diverse users.
- **Scalability**: Can be extended to support additional sign languages and integrate with more digital communication tools in the future.

V. CONVOLUTIONAL NEURAL NETWORKS (CNN)

In CNN, the processing of data involves breaking the images into many numbers of overlapping tiles instead of feedingentire images into our network. And then, we use a technique called a sliding window over the whole original image and save the results as a separate tiny picture tile. The Sliding window is a kind of brute force solution where we scan all around for a given image to detect the object for all possible sections, each section at a time until we get the expected o bject.



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5.1. Convolution Layer

Convolution Layer

CNN has a convolution layer that has several filters to perform the convolution operation.

Rectified Linear Unit (ReLU)

CNN's have a ReLU layer to perform operations on elements. The output is a rectified feature map.

Pooling Layer

The rectified feature map next feeds into a pooling layer. Pooling is a down-sampling operation that reduces the dimensions of the feature map.

The pooling layer then converts the resulting two-dimensional arrays from the pooled feature map into a single, long, continuous, linear vector by flattening it.

Fully Connected Layer

A fully connected layer forms when the flattened matrix from the pooling layer is fed as an input, which classifies and identifies the images.

VI. TEMPORAL CONVOLUTIONAL NETWORKS

The seminal work of Lea et al. (2016) first proposed a Temporal Convolutional Networks (TCNs) for video-based action segmentation. The two steps of this conventional process include: firstly, computing of low-level features using (usually) CNN that encode spatial-temporal information and secondly, input these low-level features into a classifier that captures high-level temporal information using (usually) RNN. The main disadvantage of such an approach is that it requires two separate models. TCN provides a unified approach to capture all two levels of information hierarchically.

VII. PERFORMANCES

The proposed AI-driven system enhances communication in virtual meetings by bridging the gap between deaf and hearing participants. Using advancements in deep learning, particularly Temporal Convolutional Networks (TCNs), the system enables real-time two-way communication. The Sign Recognition Module (SRM) interprets sign language, while the Speech Recognition and Synthesis Module (SRSM) converts spoken language into text. The Avatar Module visually translates speech into sign language, making communication accessible for non-signers. Trained on Indian Sign Language, the system supports diverse groups, including deaf, mute, hard-of-hearing, and visually impaired individuals. Its integration into virtual meeting platforms via a web-based interface improves accessibility and inclusivity. The system ensures seamless interaction, promoting effective communication and participation in virtual environments. This solution significantly advances accessibility in virtual meetings, fostering a more inclusive and engaging experience for all users.

VIII. RESULT AND DISCUSSION

The proposed AI-driven system successfully bridges the communication gap between deaf and hearing participants in virtual meetings by accurately recognizing and translating sign language in real-time. Experimental results demonstrate its effectiveness in improving accessibility, enabling seamless interaction for diverse groups, including non-signers and those with hearing impairments.

This AI-driven system effectively addresses the communication challenges faced by individuals with hearing and speech impairments in virtual meetings, enhancing inclusivity. By incorporating advanced deep learning techniques, it ensures seamless real-time communication across diverse groups, bridging the gap between deaf and hearing participants.

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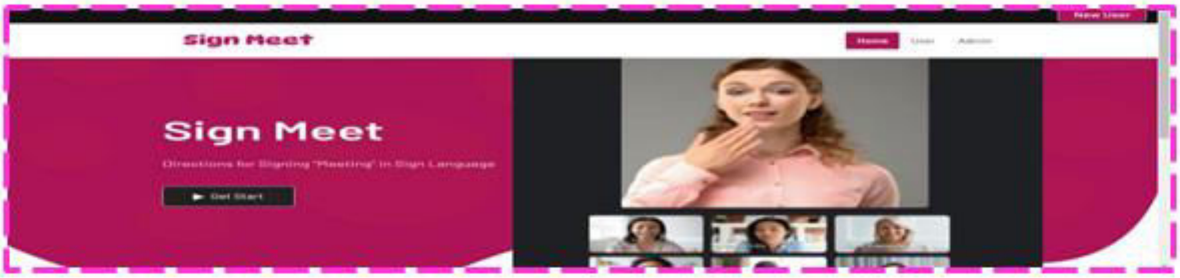

Figure.1.Home Page.

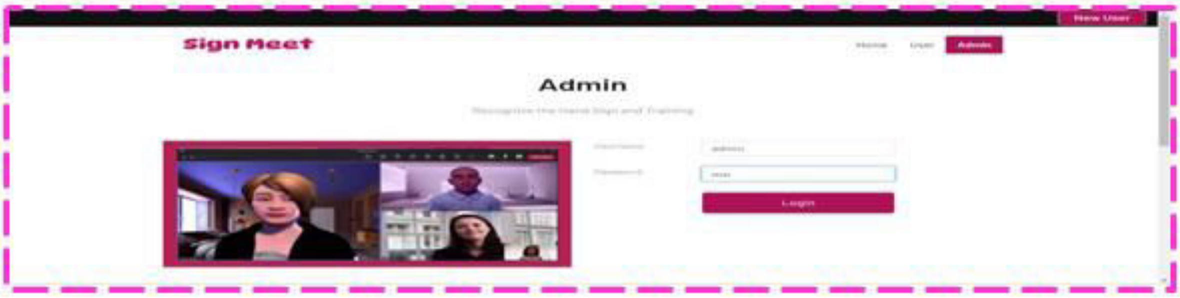

Figure.2. Admin Login Page

Figure.3. Admin training

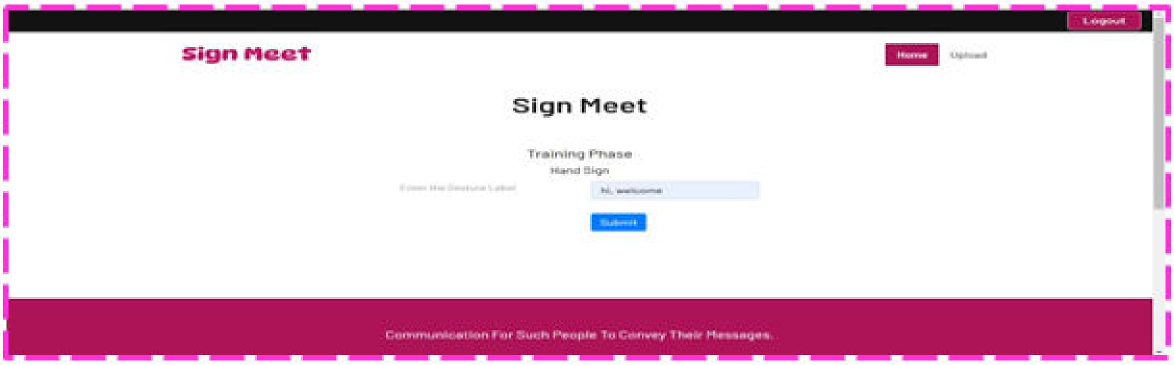

Figure.4. Home page training

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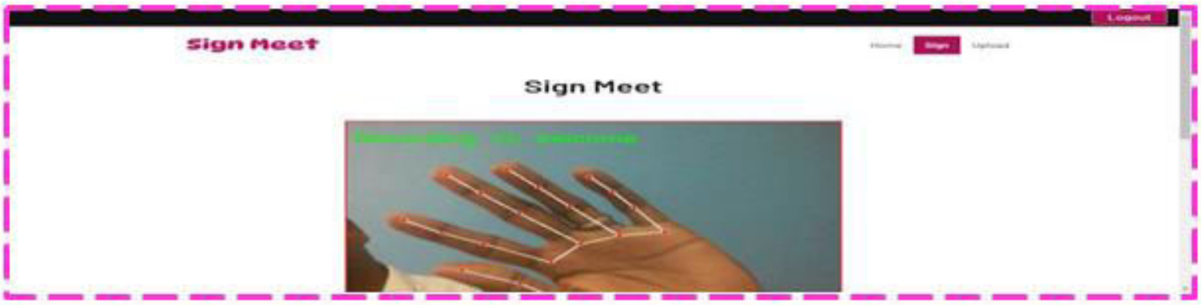

Figure 5. Train To Sings

Figure 6.Sign Modules Traing

Figure. 7.Voice to Sign

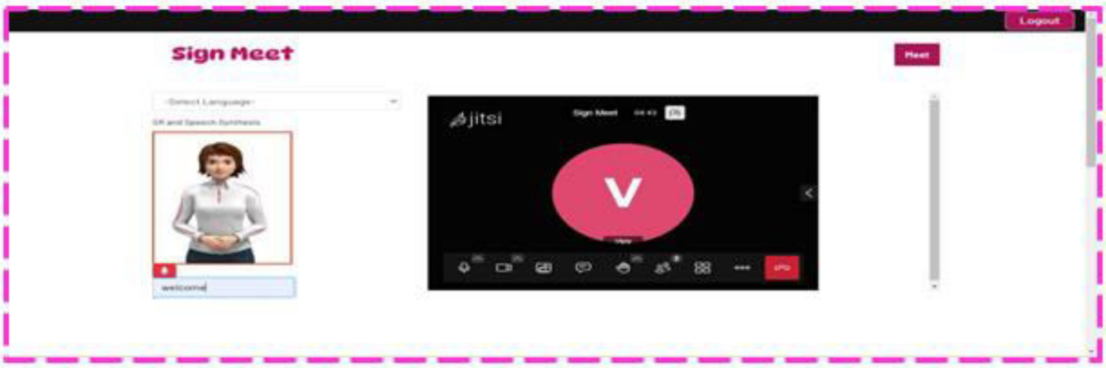

Figure.8 .Language To video call Login

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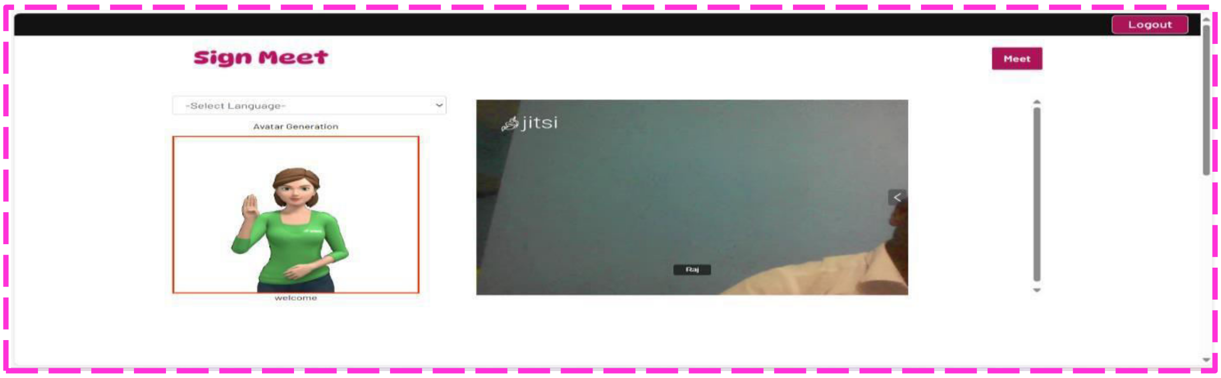

Figure.9. Speech To Text and Avatar

IX. CONCLUSION

In conclusion, the project represents a significant achievement in the realm of sports event management. The journey from inception to implementation has been characterized by innovation, collaboration, and dedication. The development of a comprehensive web application has provided a platform that seamlessly connects sports event organizers with enthusiastic participants. Through the integration of advanced algorithms such as Decision Tree for classification and CNN for clustering, personalized event recommendations have been made possible, enhancing user engagement and satisfaction. A robust notification system ensures users are promptly informed about relevant events, fostering active participation and attendance. The user-centric design prioritizes user privacy, security, and customization through effective authentication and profile management functionalities. While challenges were encountered, including algorithm optimization and community building, each obstacle served as an opportunity for learning and growth. Looking ahead, continuous innovation, global expansion, strategic partnerships, and mobile optimization are key areas for further development to elevate the video calls experiences worldwide.

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